PARENTERAL ADMINISTRATION OF FATS II. CLINICAL APPLICATION OF FAT EMULSION

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CITATION:

HIKASA, YORINORI ...[et al]. PARENTERAL ADMINISTRATION OF FATS II. CLINICAL APPLICATION OF FAT EMULSION. 日本外科宝函 1958, 27(3): 736-754

ISSUE DATE:

1958-05-01

URL:

http://hdl.handle.net/2433/206632

PARENTERAL ADMINISTRATION OF FATS
II. CLINICAL APPLICATION OF FAT EMULSION

by

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Received for publication Mar. 10, 1958

I. INTRODUCTION

It has already been shown that fat has twice the caloric value of protein or carbohydrate, is preserved in the body and is mobilized as occasion demands. Furthermore, fat is a very important material in the substance of cells as constant elements, like phospholipid, glycolipid and sterine. Fat is also important in the regulation of body temperature and for the fixation of organs by virtue of its presence in subcutaneous tissue, perivisceral, intramuscular and mesenterial tissues. Nevertheless, the nutritional value of fat has not been adequately recognized up to this time because it has been thought that protein and carbohydrate could substitute for fat. However, since it has been shown by recent studies that fat has various nutritional values and advantages which can not be substituted for this by two foodmaterials, the determination of the daily requirement of fat has become an important problem in nutrition.

In addition, in contrast to the case of carbohydrate, amino acids, vitamins and electrolytes, it has proved until recently very difficult technically to prepare a fat emulsion which could be given parenterally safely.

Earlier, Yamakawa[1] produced a fat emulsion named "Yanol" which could be infused intravenously and studied for its nutritional effects and the manner in which it was metabolized in vivo. This preparation is not widely used in Japan at present, for this was not a fat emulsion in the true sense The chief constituent of the preparation was the lecithin used as stabilizer of the emulsion.

We began to study the problem of the clinical use of fat emulsions during the Second World War. After the war we learned that these studies were proceeding in the U. S. A. at the same time. Since then, the technical problem of producing a fat emulsion was resolved in our laboratory. We have studied the nutritional value of this emulsion[8)9)] and have used it to study fat metabolism in vivo[10)].

Recently, we succeeded in producing a 20 % sesame oil emulsion which could be given safely intravenously to man[11)12)]. This report concerns the clinical results of surgical application of this 20 % sesame oil emulsion (Fatgen*). Age of emul-

* Nowadays, this improved fat emulsion is prepared by the Dainippon Pharmaceutical Company, Osaka, Japan.

sion at the time of administration varied from 1 to 10 months.

Ⅱ. MATERIALS AND METHODS

In this investigation, a 20 % sesame oil emulsion was used. This emulsion was shown paper chromatographically to be an emulsive form of the mixed glycerides of myristic, palmitic, stearic, oleic, linoleic, and linolenic acid. The size of the fat particles, for the most part, was below 0.5μ. Clinically 20 cc of a 20 % glucose solution, 10 mg of vitamin B_1, 10 mg of vitamin B_2 (riboflavin-5'-phosphate) and 100 mg of vitamin C (*l*-ascorbic acid) were simultaneously injected with 50 cc of the 20 % sesame oil emulsion. In the animal experiments calcium pantothenate and niacin amide were also employed. For exprimental animals, adult rabbits, weighing approximately 2.0 to 2.5 kg, and albino rats, weighing approximately 50 to 200 g were used.

Urinary and fecal nitrogen excretions were determined by micro-KJELDAHL analysis and urinary creatinine excretions were estimated by JAFFE'S[13] method. The paper chromatography was carried out by HIRAYAMA and NODA'S method[14)~17)] with Toyo's No. 2 filter paper. The electrophoretic analysis of sera was performed with Hitachi's HT-B Type of electrophoretic apparatus with veronal buffer solution of pH 8.6 and an ionic strength of 0.1μ.

The circulating plasma volume and the extracellular fluid were determined by Evans Blue method[22)~25)] and Ferric Nitrate method[18)~21)] respectively.

Ⅲ. RESULTS AND DISCUSSION

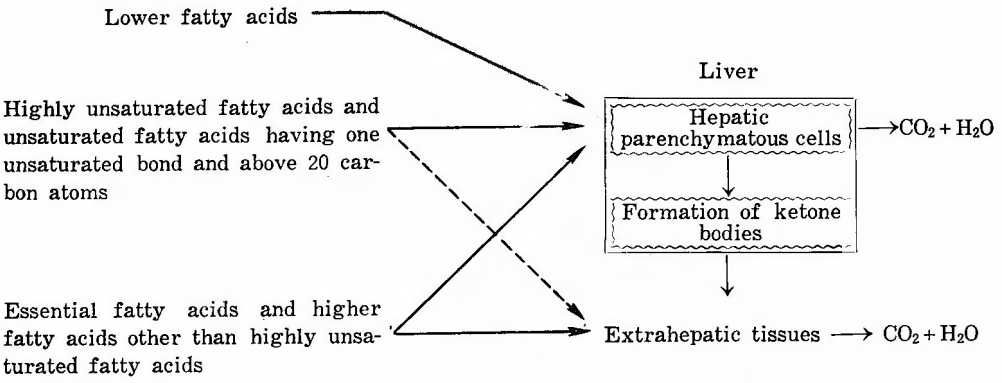
1) On the Quantity and the Quality of the Infused Fat Emulsion

Although the daily requirement of fat is not settled yet among nutrition experts, it has been observed by DEUEL[27)] that feed containing 20 to 40 % fat, such as margarine containing 30 to 43 % fat or cottonseed oil containing 20 % fat, is most suitable for the growth, procreation and lactation of mice. Based on these findings DEUEL[27)28)] suggested that one third of the total calories in a diet should be supplied from fat. Statistically, Americans and Europeans consume daily approximately 100 g of fat, while Japanese consume only 15 to 20 g, obtaining 80 % of their total calorie intake from carbohydrate.

However, differences in climate, habits and preparation of food contribute to different requirements of fat intake between Japanese and people of other nations. These differences are more important if we recall that the ability of different species to metabolize fat varies[10)]. It has also been demonstrated that unaccustomed high fat diets weaken Japanese athletes in other countries. All these considerations emphasize that fat intake administered as emulsion should be in an amount determined by the feeding habits of the animal or patient*.

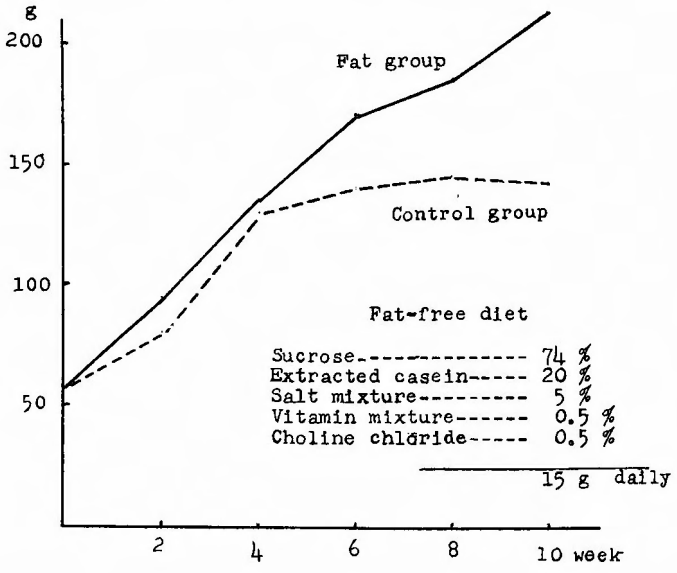
* The amounts of daily parenteral fat intake were determined by reason of the feeding habits in our country, and not by side effects which were brought about after infusion of fat emulsion.

Fig. 1 Metabolic process of fat in vivo following intravenous infusion of fat emulsion



From the results of our experimental studies[10] on the metabolism of intravenously infused fat emulsions, we learned that the emulsive forms of mixed glycerides of myristic, palmitic, stearic, oleic acid and other essential fatty acids, which are the major constituents of the sesame oil emulsion, were extremely effective as parenteral nutritional supplement. On the other hand, highly unsaturated fatty acids contained in cod liver oil emulsions were shifted chiefly into the hepatic parenchymatous cells as phospholipids, and a portion of them shifted into the extrahepatic tissues only gradually. Furthermore, from paper chromatographical studies on the components of fat emulsions, it was observed that phospholipids formed from glycerides of unsaturated fatty acids having one unsaturated bond and above 20 carbon atoms, such as eicosenoic and docosenoic also entered primarily into the hepatic parenchymatous cells, similarly to the highly unsaturated fatty acids and lower fatty acids[11] (Fig. 1). It is because of these studies that the sesame oil emulsions are mainly used in our clinic.

Fig. 2 Effects of sesame oil emulsion to growth of young albino rats



2) Nutritional Effects of Fat Emulsion

(A) Animal Experiments

Table. 1 Effect of daily infusion of sesame oil emulsion for 20 days into rabbits fed with low protein and low calorie diet. *

A: Nitrogen balance and body weight

Infused drugs	Loss of body weight (%)	Nitrogen balance (g)	Loss of storage fat (g)
(1) None	39.1 (†)	−12.383 (†)	469.0 (†)
(2) Emulsion	17.8	− 4.359	236.0
(3) Emulsion+Methionine	17.5	− 4.168	266.0
(4) Emulsion+Methionine +Riboflavin	13.7	− 3.624	194.0
(5) Emulsion+Methionine+ Riboflavin + 5% Glucose (10 cc)	8.1	− 1.808	113.0
(6) Emulsion + Methionine + Riboflavin + Vitamin C + Nicotinic Acid + 5% Glucose(10cc) + VitaminB$_1$	6.6	− 1.121	106.0

Remarks: * : The reducing diet of 27 g of wheat bran, 75g of radish leaves and water in adequate volume was given. The nitrogen content was 540 mg for wheat bran, 600 mg for radish leaves, which is the equivalent of total of 116 Cal. For the first 10 days the fat emulsion was daily infused at the rate of 0.5 g of fat per kg body weight, and for the latter 10 days, at the rate of 1.0 g of fat per kg body weight. †……Death

B: Electrophoregram of serum

Infused drugs		(1)			(2)			(3)		
Serum protein		Days of infusion			Days of infusion			Days of infusion		
		0	10	20	0	10	20	0	10	20
T. P.	g/dl	5.8	5.1		5.3	5.5	5.6	5.96	5.7	5.5
Alb.	%	59.45	59.2		62.1	60.2	56.6	62.6	63.7	56.5
α-Glob.	%	8.15	8.15	†	10.4	9.9	10.7	9.8	8.6	11.8
β-Glob.	%	16.4	18.8		16.6	18.7	19.4	16.4	18.3	20.3
γ-Glob.	%	16.0	13.85		10.9	11.2	13.3	11.2	9.4	11.4
Infused drugs		(4)			(5)			(6)		
Serum protein		Days of infusion			Days of infusion			Days of infusion		
		0	10	20	0	10	20	0	10	20
T. P.	g/dl	5.9	5.8	5.7	5.8	5.66	5.6	6.2	6.2	6.1
Alb.	%	59.8	59.7	59.7	61.1	61.2	61.4	62.5	63.0	62.5
α-Glob.	%	9.7	8.6	10.2	8.4	9.4	8.9	11.0	9.4	9.8
β-Glob.	%	19.1	19.1	19.2	17.2	17.9	18.2	15.6	15.7	16.3
γ-Glob.	%	11.4	12.6	10.9	13.3	11.5	11.5	10.9	11.9	11.4

Note: The infusion of sesame oil emulsion led to a remarkable protein sparing effect and prevented a decrease in body weight.

Recently, it has been recognized that growth of animals is stimulated by the administration of fat not only in the case of the essential fatty acids, such as linoleic and linolenic and arachidonic acids, but also by other fatty acids. The sti-

Table. 2 Effect of daily infusion of sesame oil emulsion on recovery of serum protein and body weight (Mean).

Remarks	Days of infusion after plasmapheresis	Body weight kg	T. P. g/dl	Alb. %	α-glob. %	β-glob. %	γ-glob. %
Fat Emulsion + Various Vitamins	Before plasmapheresis	2.13	5.9	60.8	11.3	14.9	13.0
	0	2.05	4.0	53.1	14.3	24.2	8.4
	5	2.02	5.3	54.7	13.1	21.2	11.0
	10	2.08	5.9	55.3	13.0	19.6	12.1
	15	2.13	6.0	59.6	11.7	15.4	13.3
Control	Before plasmapheresis	2.00	6.0	59.0	10.9	15.5	14.6
	0	1.90	3.9	50.3	11.1	29.2	9.4
	5	1.64	5.0	51.5	11.6	24.8	12.1
	10	1.76	5.4	51.2	13.8	21.0	14.0
	15	1.77	5.8	52.3	11.5	22.1	14.1

mulation of growth with sesame oil emulsion was examined by TOMIZAWA of Keio University. In his investigations, 0.125 cc of the 20 % sesame oil emulsion was injected daily into the peritoneal cavity of young albino rats weighing 50 to 60 g which were being maintained on a no fat diet. Body weights of young rats in the injected group steadily and markedly increased until the 10 th week, while in the control group the weight increased only to the 4 th to 5 th week and decreased after 10 weeks (Fig. 2). These results demonstrated clearly that the sesame oil emulsion containing linoleic, linolenic and other fatty acids greatly promotes the growth of young rats.

FRENCH[30] stated that the growth of young rats fed low protein diets is incremented by taking fat. PEARSON and PANZER[31] demonstrated that the excretion of amino acids was decreased after the administration of fat. Thus, fat metabolism is connected with protein metabolism, and a "Protein Sparing Effect" in the body is brought about by the administration of fat or carbohydrate, and in particular by the simultaneous administration of both as shown by SWANSON[32]. TSUKADA[9] and OSA[8] in our laboratory demonstrated the protein sparing effect in adult rabbits fed low calorie and low protein diets following the repeated intravenous administration of sesame oil emulsion. OSA proved that the simultaneous administration of the sesame oil emulsion with glucose solution and various vitamins showed a remarkable protein sparing effect, maintained the normal levels of plasma protein, and prevented a decrease in body weight (Table 1). In addition, it was shown that the intravenous administration of this fat emulsion into rabbits in a state of hypoproteinemia, produced by plasmapheresis for 7 days, caused more effective utilization of orally administered protein in the synthesis of plasma and tissue protein (Table 2). The above experimental results illustrate the nutritional importance of fat in general and of the sesame oil emulsion developed in this laboratory in particular. It is because of these studies that the author studied the clinical application of this fat emulsion in the following cases.

(B) Clinical Application

(i) Side Effects

In our earlier clinical studies on the use of the sesame oil emulsion and various other types of fat emulsion many side effects, such as flushing of the face, heaviness in the chest, dyspnea, vomiting, headache, back pain, chills, fever, urticaria, and a decrease in red blood corpuscles were occasionally observed after the intravenous injection of these fat emulsions.

OTANI[33] in our laboratory assumed that these side effects were caused by colloid shock or hemolysis and examined hamosiderin deposits in the spleen after the repeated infusion of the fat emulsion into rabbits. Hemosiderin deposition in the spleen markedly increased after the injection of the fat emulsion containing lower and highly unsaturated fatty acids. These findings are not enough to say that sesame oil emulsion is the most satisfactory fat emulsion. However, we have observed that the clinical side effects as back pain, headache, or vomiting were less noticeable after the administration of sesame oil emulsion than after the use of other fat emulsions containing the lower and highly unsaturated fatty acids.

More recently in our laboratory we produced a sesame oil emulsion, which could be repeatedly infused without hemolysis. However, clinical side effects of the sesame oil emulsion, such as flushing of the face, fever and heaviness in the chest could not be prevented completely even by means of the simultaneous infusion of glucose solution and various vitamins. Nor aid dilution with physiological saline solution affect these clinical side effects in patients. On the other hand, a decrease in blood pressure and tachypnea, which were caused by colloid shock, did not occur after the intravenous infusion of this fat emulsion into cats.

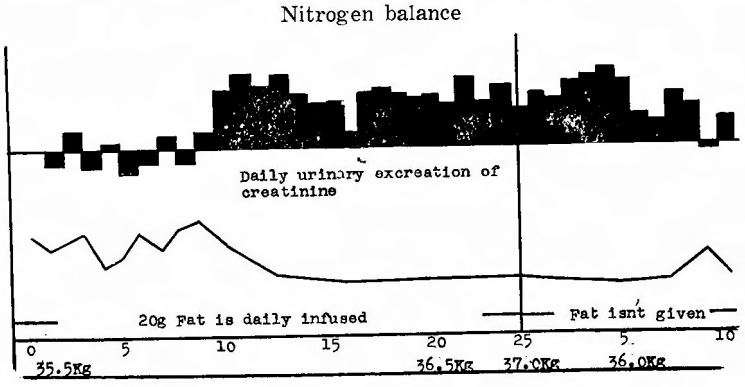
Recently, HANABUSA[34] and TAMAKI[35] in our laboratory, noticed that these clinical side effects were abolished by the simultaneous injection of RINGER'S solution with

Table. 3 Chart depicting reaction rates using the Fatgen for intravenous administration according to number of subjects and number of infusion (Since May, 1957)

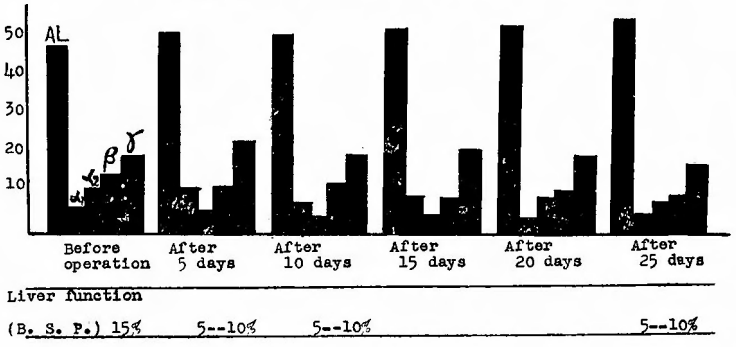
Emulsion	Fatgen			
Number of infusions Number of subjects	1305 83			
Reactions	Number of infusions	Per cent per infusion	Number of subjects	Per cent of subject
Fever	0	0	0	0
Chill	0	0	0	0
Back and chest pain	1	0.077	1	1.21
Flushing	1	0.077	1	1.21
Nausea and vomiting	0	0	0	0
Shock	0	0	0	0
Rash	0	0	0	0
Miscellaneous	0	0	0	0
Over-all		0.077		1.21
Remarks	Age of the emulsion at the time of administration varied from 1 to 10 months.			

Fig. 3 Nutritional effects of sesame oil emulsion in a case of esophageal stenosis

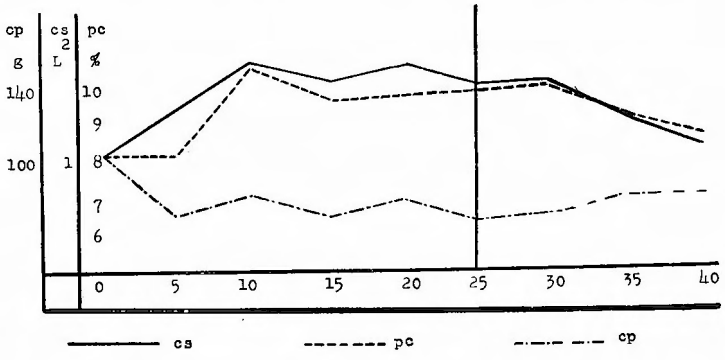
A: Nitrogen balance and urinary creatinine excretion



B: Electrophoregram of serum protein and liver function



C: Circulatory serum protein and circuratory serum volume



Circulatory serum volume……cs
Serum protein concentration……pc
Total circulatory serum protein……cp

sesame oil emulsion (Table 3). This fact shows that various electrolytes play a very important role in the metabolism of the infused fat. Unfortunately, these electrolytes can not be previously mixed with the fat emulsion, because such solutions are not stable at room temperature for long enough. Therefore, RINGER'S solution should be mixed with the sesame oil emulsion just before intravenous injection. This is a weak point of the sesame oil emulsion at present. However, this fat emulsion may be kept safely at normal temperature prior to the addition of RINGER'S solution and has caused no tissue reaction or encephalographic change after intravenous injection in man.

(ii) Nutritional Effects

In the present study[12], 8 patients of similar age and weight, who had about the same concentration of serum protein, serum electrophoretic pattern and circulating plasma volume were daily injected simultaneously with 100 cc of the 20% sesame oil emulsion and glucose solution together with various vitamins while on a low calorie (800 Cal. daily) and low protein (20 to 25 g daily) diet. The nitrogen balance which had been negative became positive when the emulsion was begun. The urinary creatinine gradually decreased, the concentration of serum protein increased, and the serum electrophoretic pattern was markedly improved after the injections began. One representative case is presented here. The patient had swallowed strong alkali in order to commit suicide and though prompt measures had prevented death a marked stenosis of the esophagus had resulted with complete inability to take food by mouth. A jejunal fistula had been constructed surgically and forced feeding (about 1800 Cal. daily) through this opening had been attempted. However, there had been no improvement in the nutritional state of this patient. One month after the construction of the fistula the daily intravenous administration of 100 cc of the 20 % sesame oil emulsion was started. The nitrogen balance which had been negative side became normal about one week after starting the injections and the urinary creatinine gradually decreased. The circulating serum volume returned to normal levels, and the concentration of serum protein which had become abnormally high due to dehydration gradually dropped. The total protein content of the circulating blood increased and there was a marked increasing in body weight and an improvement in the serum electrophoretic pattern (Fig. 3).

In addition, the sesame oil emulsion was repeatedly administered for 5 days before and for 10 days after gastrectomy on patients with gastric cancer and gastric ulcer and its nutritional effects were recorded. In the group given fat parenterally the nitrogen loss was one half that of the control group and the period of negative nitrogen balance was markedly shortened when compared with control patients (Fig. 4). Examination of electrophoretic patterns showed that in the fat injected group the return to a normal pattern took place in shorter time than in the control group (Table 4).

From these findings it is evident that the sesame oil emulsion is extremely effective from a nutritional standpoint. It has a protein sparing effect. It increases weight gain and protects against catabolism.

Table. 4 Nutritional effects of sesame oil emulsion to surgical patients prior to and after gastrectomy

A: Gastric cancer cases

Group	Days of examination	Serum protein: Conc. of serum protein (g/dl)	Electrophoretic fraction (%): Alb.	α_1-glob.	α_2-glob.	β-glob.	γ-glob.	Ratio A/G	Circulatory serum protein (g)	Nitrogen balance (g) {( )negative {summay}	Change of body weight (%)
Fat Group	Befor	7.3	48.63	6.91	7.96	13.01	23.49	0.946	168	—	—
	After 5 days	7.8	45.24	6.21	9.91	15.49	23.16	0.826	159	−34.3	−5.4
	After 10 days	7.0	48.25	5.32	8.84	14.94	22.65	0.933	186	−18.8	−2.6
	After 15 days	6.9	51.52	4.61	6.88	13.48	23.82	1.021	162	(−53.1)	−2.9
Control	Before	7.2	46.24	6.41	11.41	12.36	23.57	0.860	151	—	—
	After 5 days	7.9	43.14	6.49	11.49	15.41	24.47	0.759	127	−70.4	−6.7
	After 10 days	6.7	45.11	7.49	10.17	12.41	24.82	0.822	133	−26.2	−5.3
	After 15 days	6.7	46.12	6.41	9.32	13.96	24.19	0.856	150	(−96.6)	−5.7

(Mean value)

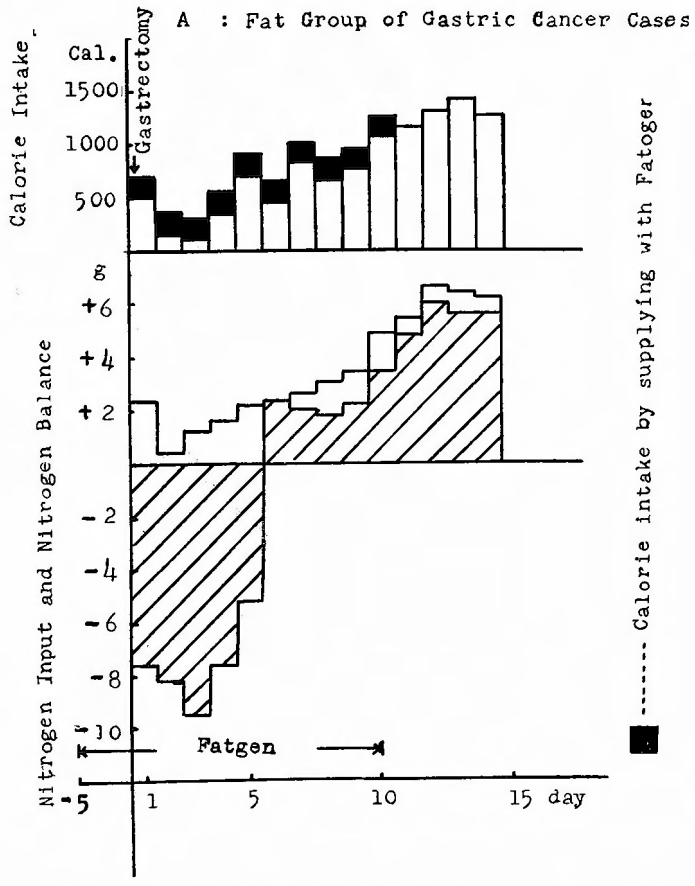
B: Gastric ulcer cases

Group	Days of examination	Serum protein: Conc. of serum protein (g/dl)	Electrophoretic fraction (%): Alb.	α_1-glob.	α_2-glob.	β-glob.	γ-glob.	Ratio A/G	Circulatory serum protein (g)	Nitrogen balance (g) {( )negative {summary	Change of body weight (%)
Fat Group	Befor	7.4	51.49	4.71	9.32	15.07	19.41	1.061	161	—	—
	After 5 days	7.9	47.21	3.93	9.72	16.24	22.87	0.894	145	−41.4	−6.6
	After 10 days	6.8	50.76	5.72	7.42	15.96	20.14	1.031	149	− 2.3	−4.7
	After 15 days	6.9	51.94	4.72	6.92	14.76	21.66	1.081	160	(−43.7)	−4.7
Control	Before	7.3	53.49	3.91	7.01	15.97	19.66	1.148	164	—	—
	After 5 days	8.0	46.34	7.96	8.24	16.32	21.14	0.864	142	−52.8	−6.8
	After 10 days	7.0	46.86	8.76	9.22	16.49	17.69	0.882	150	−43.1	−7.3
	After 15 days	6.9	49.37	7.94	8.02	14.98	19.69	0.975	159	(−95.9)	−6.4

(Mean value)

Previously, TATSUMI[11] and SHIMADA[36] in our laboratory, reported that there was no abnormal rise in serum lipids with repeated injections of fat before and after surgical operations (Fig. 5). Thus, this sesame oil emulsion can be given parenterally safely and has a strong sparing action on protein metabolism even in the laparotomized patient. The nutritional effects following the intravenous administ-

Fig. 4 Changes in nitrogen balance after gastrectomy

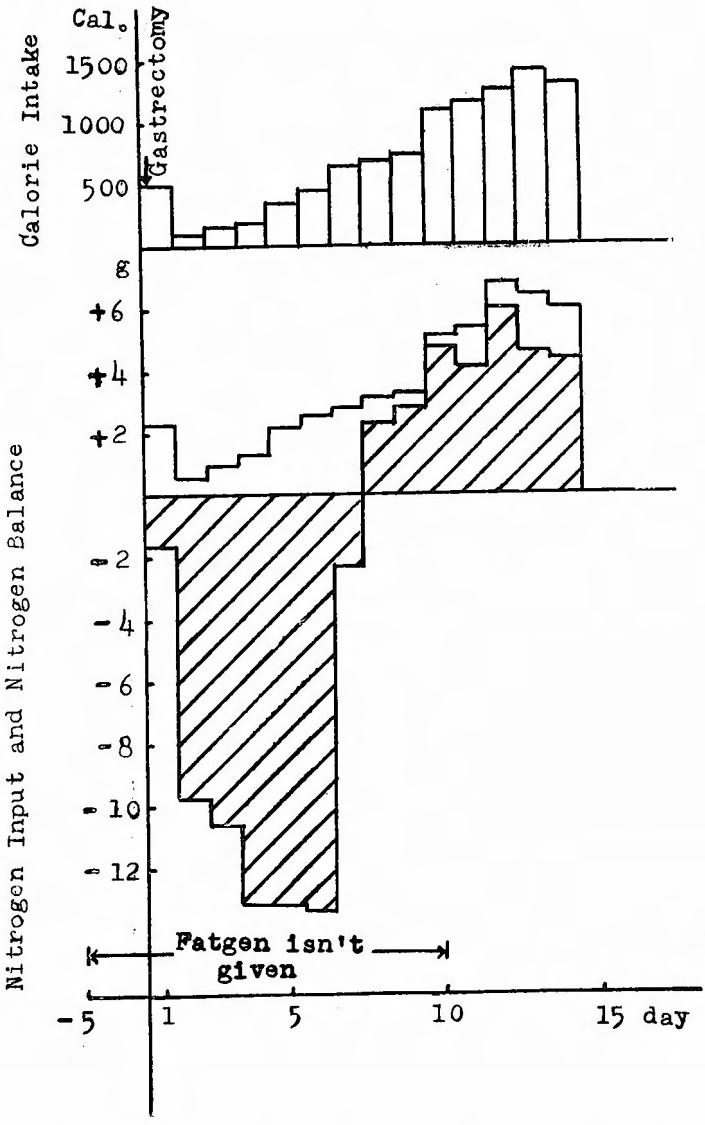


ration of the sesame oil emulsion not only after but also before and after surgical operation were studied from the point of view of nitrogen loss. The nitrogen loss was reduced to a greater extent in the latter case than in the former case. Therefore, from the view-point of nitrogen loss and nitrogen balance, the pre- and post-operative infusion of sesame oil emulsion is the most advantageous method of administration to lessen the danger of operation and to foster an early recovery from illness. These findings agree with those obtained by SAMUELS[37)38)] and SWANSON who studied protein metabolism following the oral administration of fat in fasted animals.

However, as shown in Fig. 4, these findings were obtained in the case of the infusion of fat emulsion to patients administered low protein and low calorie diets. What effect has the infusion of fat emulsion on patients administered high protein and high calorie diets?

To solve this problem, 100cc of 20% sesame oil emulsion were intravenously injected daily for 5 days to patients administered high protein and high calorie diets by tube feeding immediately after surgical operation, and changes in nitrogen balance and serum protein components were examined[34)]. In this case, serum protein

B: Control Group of Gastric Cancer Cases

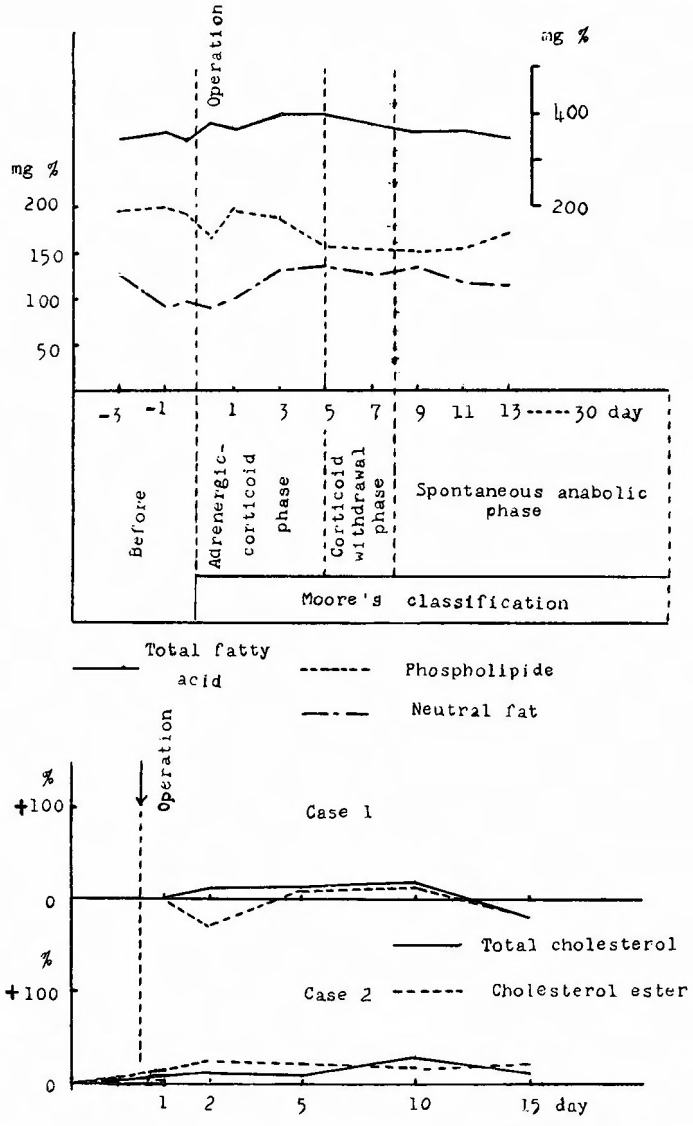


concentration and electrophoregram were markedly recovered after surgical operation on the contrary with control, and an effect of fat emulsion was found from the view-point of nitrogen balance (Fig. 6 and Table 5).

From these facts, it is evident that our fat emulsion is very effective to the reconstruction of tissue protein and serum protein which is the most important role of postoperative nutritional supplements. We also studied serum electrophoretic tests and brom-sulphalein tests in our patients to preclude the possibility of hepatic disturbances in the case of the infusion of this fat emulsion in so far as possible.

(iii) On Fluid Metabolism

Fig. 5 Changes of blood lipid levels before and after gastrectomy at the time of repeated infusions of sesame oil emulsion

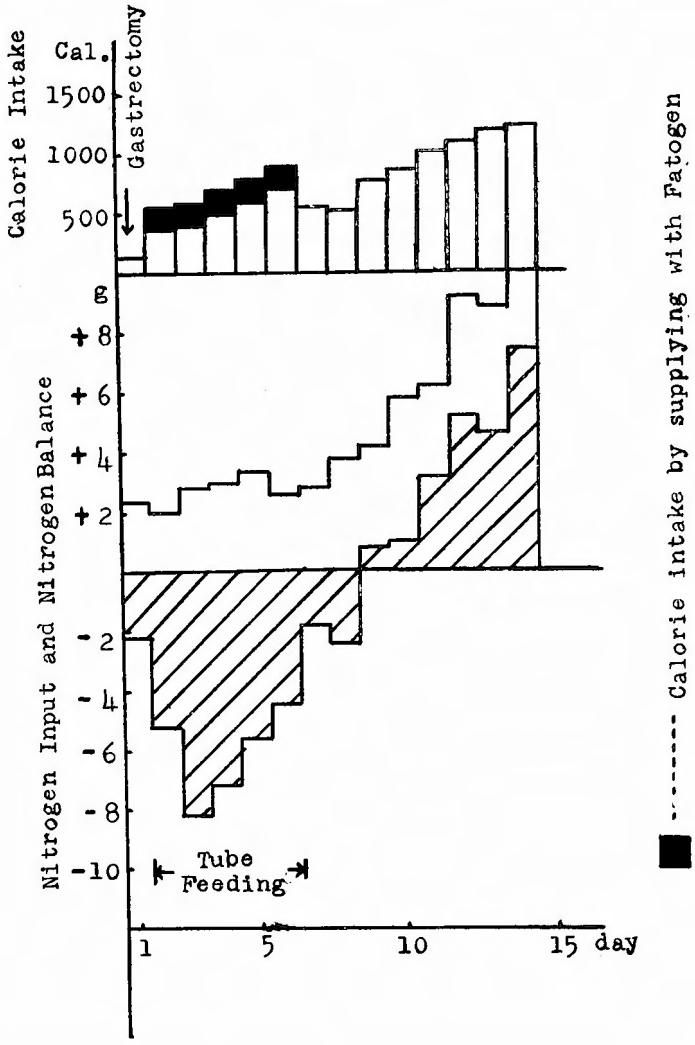


One important question in our minds was whether or not the colloid nature of the sesame oil emulsion might cause a change in fluid metabolism in the body. In the healthy adults no remarkable changes in the circulating plasma volume and the extracellular fluid volume following repeated intravenous infusions of the sesame oil emulsion with glucose solution and various vitamins were noted. Therefore, we feel that this fat emulsion causes neither overhydration nor dehydration in healthy adults (Fig. 7).

Furthermore, changes in the circulating plasma volume and the extracellular

Fig. 6 Nutritional effects of sesame oil emulsion to surgical patients administered high protein and high calorie diets after gastrectomy

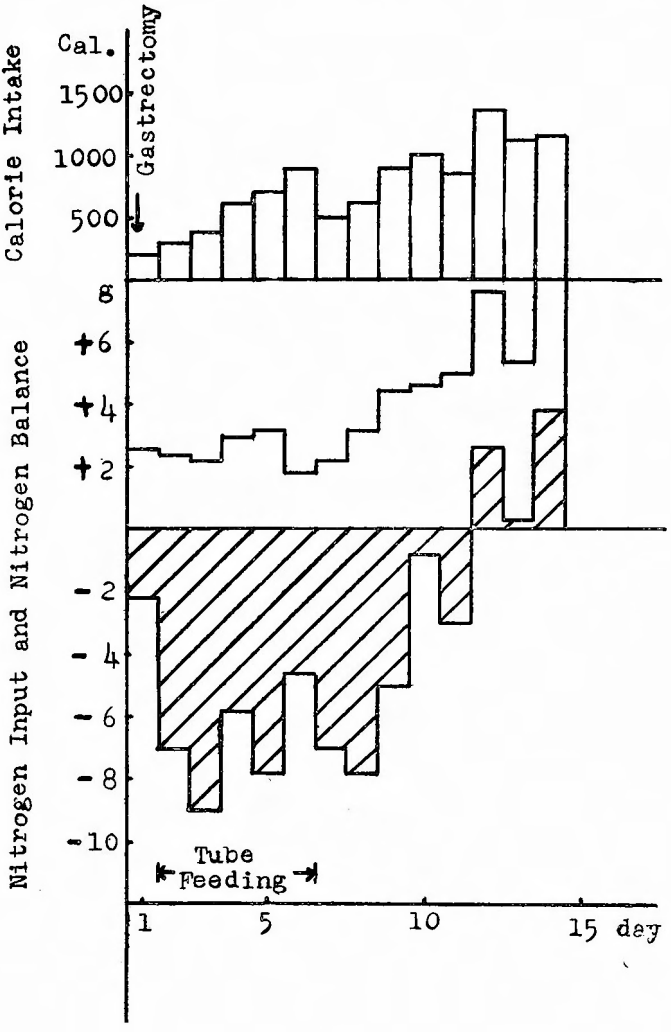
A: Fat Group



fluid after gastrectomy were examined. Cases were divided into two following groups: one was the group given daily 1100 cc of RINGER's solution and the other was given 2000 cc daily. The extracellular fluid remarkably decreased in the former group, but showed normal values in the latter group.

On the other hand, a mixture of 100 cc of 20% sesame oil emulsion and 1000 cc RINGER's solution was daily administered by drip method intravenously into the gastrectomized patient. In this case, the circulating plasma volume and the extracellular fluid maintained the normal levels after surgical operation (Fig. 8). Also from the view-point of the prevention of the side effects described above, we know that the simultaneous administration of RINGER's solution is an advantageous

B: Control Group



method for the injection of the sesame oil emulsion. One explanation of the effect of fat administration on fluid metabolism might be the increased plasma colloidal osmotic pressure which might follow the intravenous administration of fat (Fig. 8).[35]

However, these phenomena can not be explained completely by the fact that the infusion of fat emulsion is of great advantage to maintaining the normal level of plasma colloidal osmotic pressure. The relation of extracellular fluid and plasma colloidal osmotic pressure should be understood by NAGASE's experimental result[39] that the capillary resistance and permeability of cellular membrane are maintained normal levels by full administration of essential fatty acids. But the details of this fluid metabolism must be studied further.

IV. CONCLUSION

Table. 5 Nutritional effects of sesame oil emulsion to surgical patients administered high protein and high calorie diets after gastrectomy

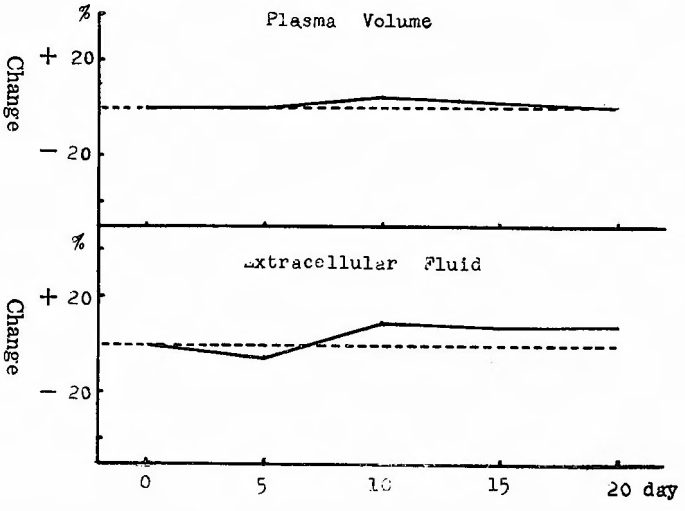
A: Fat Group

Days of examination	Serum protein							Circulatory Serum protein (g)	Nitrogen balance (g)	Change of body Weight (%)
	Conc. of serum protein (g/dl)	Electrophoretic fraction (%)					Ratio A/G			
		Alb.	α_1-glob.	α_2-glob.	β-glob.	γ-glob.				
Before	6.8	39.88	9.44	8.59	18.38	23.71	0.663	126	—	—
After 1week	6.6	38.21	7.69	11.53	18.50	24.07	0.618	121	−34.7	−3.8
After 2weeks	6.9	38.47	6.59	14.45	14.90	25.59	0.625	143	−37.1	−3.1

B: Control Group

Days of examination	Serum Protein							Circulatory serum protein (g)	Nitrogen balance (g)	Change of body weight (%)
	Conc. of serum protein (g/dl)	Electrophoretic fraction (%)					Ratio A/G			
		Alb.	α_1-glob.	α_2-glob.	β-glob.	γ-glob.				
Before	6.3	36.23	4.57	11.31	16.14	31.75	0.568	134	—	—
After 1week	6.3	32.09	5.20	13.64	18.82	30.25	0.473	120	−43.3	−5.6
After 2weeks	6.2	33.10	4.07	10.53	17.16	35.14	0.495	137	−60.5	−5.0

Fig. 7 Changes in the circulating plasma volume and the extracellular fluid volume following repeated infusions of seeame oil emulsion (Healthy adults)



Surgeons have often noted that the success of an operation depends upon the nutritional condition of the patient. Caloric insufficiency and dehydration in the preoperative state have often caused shock and functional disturbances of the heart,

Fig. 8 Changes in plasma colloidal osmotic pressure and extracellular fluid volume following simultaneous administration of sesame oil emulsion with 1000 cc of Ringer's solution before and after gastrectomy (Mean)

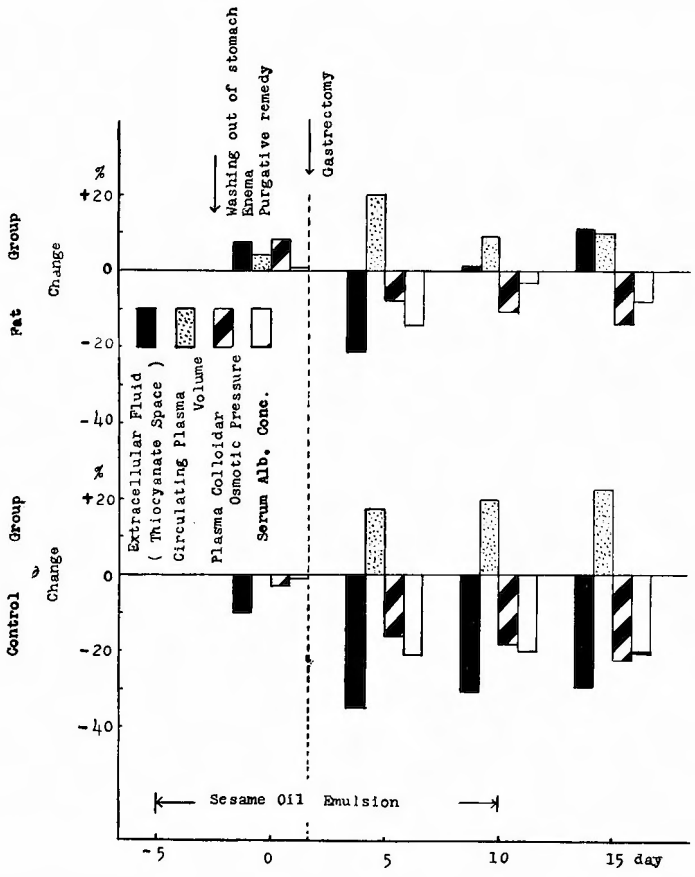
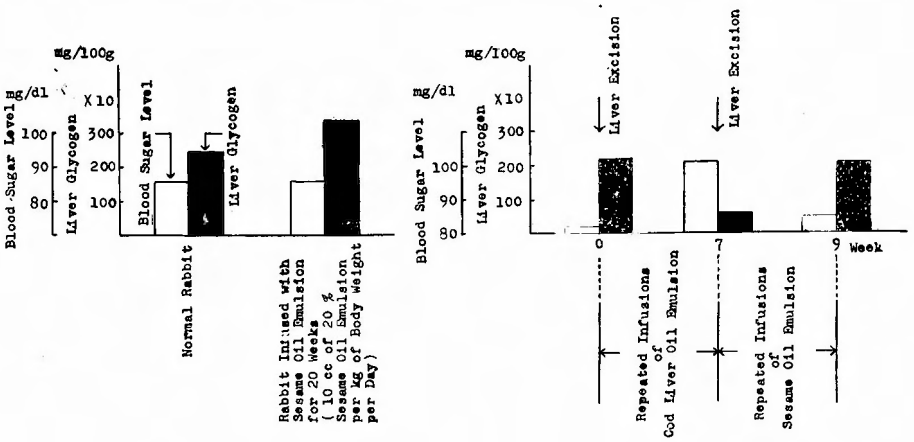


Fig. 9 Effect of Daily Infusion of Sesame Oil Emulsion on Liver Glycogen



liver and kidney, and delayed the healing of operative wounds.

Accordingly, in a surgical operation the presence of a full supply of nutriments is very important thing, as important as modern improvements in operative method, anesthesia, and in the prevention of an infection. It is not necessary to say that fat is the most advantageous nutrient with respect to caloric value[40)41)]. Notwithstanding, so far a very few studies on parenteral nutrition with fat have been performed[42)~52)]. This is in contrast to carbohydrate, amino acids, electrolytes and vitamins. In 1945 we began to study these problems and recently succeeded in producing a 20% sesame oil emulsion which could be safely given intravenously to man. In this paper, the nutritional effects of this fat emulsion have been clarified by animal experiments and clinical applications in surgery.

The intravenous administration of the sesame oil emulsion caused a remarkable protein sparing effect, in particular in the case of accelerated catabolic metabolism. These results agreed with those obtaind by SWANSON who studied the protein sparing effects of orally administered fat. From our findings, this preparation should be used not only as a postoperative treatment, but also as a preoperative medication. At the present time, the question of fluid metabolism as affected by fat awaits further study.

V. SUMMARY

We succeeded in producing a 20% sesame oil emulsion which could be safely given intravenously. We observed the clinical effects of this preparation on protein metabolism and noted the following results.

(1) The simultaneous infusion of various electrolytes, in particular RINGER's solution, with the sesame oil emulsion prevented side effects completely.

(2) This preparation can be kept at normal room temperatures for a long term.

(3) The intravenous administration of the sesame oil emulsion caused a remarkable protein sparing effect. This was particularly true in the case of an accelerated catabolic metabolism in the body. The administration of the fat emulsion produced an actual increase in body weight. From these results, it is evident that the sesame oil emulsion is extremely effective as a nutritonal supplement before and after surgical operation.

(4) The parenteral injection of the sesame oil emulsion improved fluid metabolism in the body.

(5) From paper chromatographical studies, the fatty acids having above 20 of carbon atoms, even in the case of one double unsaturated bond, chiefly shifts into the liver in the form of phospholipid.

The authors wish to express sincere gratitude both to the workers in the Laboratory of Dainippon Pharmaceutical Limited Company, and to Dr. SADATAKE KATO, the Director of the Research Division of this Company (Director: TOKUJIRO MIYATAKE) for their kind assistance in the course of the work. The author's grateful thanks are due to Dr. SETSUO TOMIZAWA, Pharmacological Division of Keio University, for his helpful guidance.

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